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Grassland Prototype Validation Exercise (PROVE) at Jornada Experimental Range

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Introduction

A diverse group of researchers from both within and without the EOS community gathered in late May at the Jornada Experimental Range near Las Cruces, New Mexico for the Grassland Prototype Validation Exercise (PROVE). Grassland represents the first PROVE campaign (a Forest PROVE was held in August), and was the result of a joint agreement by MODIS, MISR and ASTER, and also included participants from the USDA-Agricultural Resource Service (ARS), Jornada Long Term Ecological Research Project (LTER), Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC), Boston University, and the Universities of Arizona, Colorado, Montana, Nebraska and Oklahoma. GSFC Physical Scientist Jeff Privette, who helped coordinate the activity, stated that, "The PROVE campaigns focus on how quickly and accurately we can measure the relevant parameters for the validation of MODIS and other AM instrument products over a range of surface conditions. During the PROVE campaigns we are prototyping remote sensing algorithms, as well as methods for collecting field data commensurate with satellite spatial resolutions, and asking how we can measure the relevant parameters on the ground to validate the planned remote sensing products."

Background

The Jornada Range contains a large (roughly 50x100 miles) and extremely flat valley which is slowly undergoing a landcover change from grassland to shrubland (predominantly mesquite). Because of this landcover change, three distinct areas exist: grassland, shrubland (mesquite) and transitional (mixed grass and shrub). The area is semi-arid, so grass and shrub cover is sparse (the average leaf area index [LAI] is roughly 0.5). There are very few manmade structures in the whole Jornada area, with the exception of a few unpaved roads, a data tower, and some fences, meaning that contributions from non-target components in remote sensing data are very small.

Data Collection Strategy

PROVE researchers utilized USDA-established data collection sites in each of the three landcover areas, although high dunes surrounding the mesquite bushes in the shrubland area were problematic. Privette explained that the effects of the surrounding dunes on the measurements are still not well-understood. Researchers focused their efforts on the grassland and transitional sites and employed airborne, tower- and ground-based instruments and data collection techniques. First, PROVE set out to collect airborne remote sensing data over different spectral, angular and spatial ranges with AirMISR, the MODIS Airborne Simulator (MAS), the Advanced Visible and Infrared Imaging Spectrometer (AVIRIS), and an Exotech radiometer. These data sets could be collected over most of the Jornada area, and should adequately address issues of scaling. Second, a CIMEL sunphotometer was mounted on a cherrypicker at the grassland site, and later moved and remounted near the top of a 100-foot tower at the transitional site. Third-generation Portable Apparatus for Rapid Acquisition of Bidirectional Observation of Land and Atmosphere (PARABOLA) instruments were collocated using the cherrypicker at both the grassland and transitional sites. Third, ground crews collected LAI, fraction of absorbed photosynthetically active radiation (fAPAR), and surface temperature data along transects at the grassland and transitional sites. Digital photographs were taken along the transects, and many other variables were also measured.

Airborne data collection was hampered by the last-minute unavailability of MAS and AirMISR. However, PROVE did acquire high spectral resolution data from AVIRIS, and angular data that would have been supplied by AirMISR were obtained through a combination of Polarization and Directionality of Reflectances (POLDER), Geostationary Operational Environmental Satellite (GOES), Advanced Very High Resolution Radiometer (AVHRR), and airborne Exotech data. Privette felt confident that, despite the loss of AirMISR and MAS data, researchers were able to substitute other data sets and still accomplish their remote sensing data collection goals. He noted that they were very fortunate to receive POLDER data before the ADEOS satellite became inoperative in late June. He added that PROVE prototyped a method to quickly obtain just the Jornada subscenes of GOES data. A commercial GOES supplier sent the data to the ORNL DAAC within a few hours of acquisition. Researchers in the field could then use a laptop computer to access images from Oak Ridge and, for instance, obtain aggregate values for albedo or surface temperature. Allowing for spectral differences, these data could be compared to data collected with ground- and tower-based instruments, and researchers could at least plot data and compare curves. PROVE researchers did not access the GOES data from the field, but Privette expects that future campaigns will utilize this capability.

A CIMEL sunphotometer mounted on a cherrypicker (grassland and transitional sites) and a tower (transitional site) was used to gather both surface and atmospheric data that allow calculation of parameters such as Bidirectional Reflection Distribution Function (BRDF) and aerosol optical depth. CIMEL data were transmitted in near-real time, via GOES and the Aerosol Robotic Operational Network (AERONET), to Wallops Island and archived. AERONET then made the images available online. Privette pointed out that Brent Holben of Code 923 was instrumental to this effort. PARABOLA III data were downloaded to a laptop computer in the field by JPL investigators. This data will be cleaned up and eventually archived at ORNL. Privette noted that the PARABOLA III has 8 separate bands, whereas the original model had only 3 bands. The PARABOLA III was prototyped on the BOREAS campaign, and will be validated by PROVE. MODIS researchers at GSFC and MISR researchers at JPL are eager to compare the CIMEL and PARABOLA III data, especially with regard to determining BRDF.

Ground data were collected with a variety of instruments, giving a first look at consistency of results between the different BRDF instruments and, later, to compare ground data to satellite data. The University of Arizona (UA) team made ground Exotech, quantum sensor, ceptometer, infrared thermal (IRT) and Modular Multiband Radiometer (MMR) measurements. The UA team took digital and GPS photographs, and also measured fraction cover and obtained soil samples. The Boston University team took multiple albedo measurements at all the sites, under various solar conditions, in an attempt to show how albedo varies during a day. The University of Colorado team made LAI measurements with a Licor LAI-2000, and fAPAR measurements with a Licor line quantum sensor. This team also measured leaf optical properties and leaf angles. GSFC, ORNL, USDA-ARS and University of Oklahoma researchers made destructive measurements of LAI for selected mesquite, yucca and Mormon tea data points. (These three plants account for virtually all of the vegetation cover at the Jornada Range.)

Accomplishments

When asked to discuss PROVE's successes, Privette cited three primary accomplishments. First, the MODIS Land team joined with other AM-1 instrument teams, interdisciplinary science investigators, and university and government agency scientists to develop strategies envisioned for field measurements at EOS validation sites. Second, participants prototyped sampling schemes and instrumentation envisioned for MODIS land product validation. Third, participants gathered simultaneous, coherent data for all major parameters (land and atmosphere) affecting remote sensing signals. Privette explained that modelers had identified the parameters that they wanted to measure, but did not always know the best instrument or method to collect the necessary data. With PROVE, cooperation between the modeling and measurement communities should help to ensure that the most useful data collection methods were used. Dick Olson from the ORNL DAAC

participated in ground data collection in order to provide feedback from an EOS validation data archiving and management perspective. New instruments used by PROVE included the third-generation PARABOLA III, and Exotechs mounted off-nadir on light aircraft. New digital photography methods were also employed. While CIMEL sunphotometers have been used successfully by past field campaigns, PROVE represents the first time that CIMEL data were used to measure surface directional reflectance. Privette indicated that so far use of the new instruments appears to have been successful, although further data analysis is necessary before a real assessment can be made. Finally, the use of multiple instruments taking similar measurements of the same parameters should ensure a coherent data set. Preliminary comparison between instruments indicates that measurements agree. Privette added that a significant amount of satellite data were collected during this period (including 137 AVHRR scenes provided by the University of Colorado), and this data will be compared to the various instrument data.

In a broader sense, Privette felt that PROVE was a success in that it brought together, in one place and time, researchers from both within and without the EOS community in the context of EOS product validation. The various research teams each had different strengths and emphases, and future campaigns will hopefully be able to play to these strengths. PROVE also allowed EOS and non-EOS researchers to share and compare data collection methods, as well as establish contacts in preparation for similar mini-campaigns after the launch of the AM platform.

Continuing PROVE Activities

Analysis of the vast amount of data collected is ongoing. Some EOS researchers will likely rejoin USDA researchers to collect supplemental data from Jornada in September, when the grassland region will be green following the August monsoons. A Forest PROVE campaign was held in the beginning of August at the Walker Branch Watershed in Oak Ridge, Tennessee, and results from the Grassland and Forest exercises will be compared. Additional PROVE activities are being discussed for the first half of 1998.